

# Chemical Compounds in Cells

## Reading Preview

### Key Concepts

- What are elements and compounds?
- What are the main kinds of organic molecules in living things?
- How is water important to the function of cells?

### Key Terms

- element • compound
- carbohydrate • lipid
- protein • amino acid
- enzyme • nucleic acid
- DNA • RNA

## Target Reading Skill

### Comparing and Contrasting

As you read, compare and contrast carbohydrates, lipids, and proteins in a table like the one below.

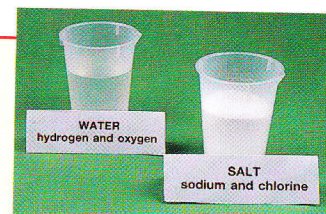
Type of Compound	Elements	Functions
Carbo-hydrate	Carbon, hydrogen, oxygen	
Lipid		
Protein		

Lab zone

## Discover Activity

### What Is a Compound?

1. Your teacher will provide you with containers filled with various substances. All of the substances are chemical compounds.
2. Examine each substance. Read the label on each container to learn what each substance is made of.



### Think It Over

**Forming Operational Definitions** Write a definition of what you think a chemical compound is.

Watch out—you are surrounded by particles that you can't see! Air is made up of millions of tiny particles. They bump into your skin, hide in the folds of your clothes, and whoosh into your nose every time you take a breath. In fact, you and the world around you, including the cells in your body, are composed of tiny particles. Some of these particles are elements, and others are compounds.

## Elements and Compounds

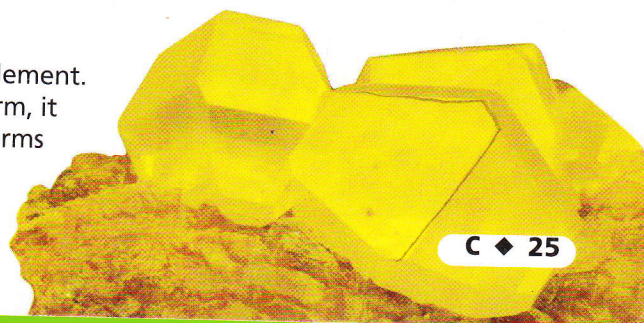
You may not realize it, but air is a mixture of gases. These gases include both elements and compounds. Three gases in the air are oxygen, nitrogen, and carbon dioxide.

**Elements** Oxygen and nitrogen are examples of **elements**. **An element is any substance that cannot be broken down into simpler substances.** The smallest unit of an element is called an atom. An element is made up of only one kind of atom. The elements found in living things include carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur.

FIGURE 16

### An Element

Sulfur is an element. In its pure form, it sometimes forms crystals.





**Compounds** Carbon dioxide is a **compound** made up of the elements carbon and oxygen. **When two or more elements combine chemically, they form a compound.** Most elements in living things occur in the form of compounds.

The smallest unit of many compounds is called a molecule. A molecule of carbon dioxide consists of one carbon atom and two oxygen atoms. Water is another compound. Each water molecule is made up of two hydrogen atoms and one oxygen atom. In Figure 17, notice the diagrams of carbon dioxide and water molecules.

**Organic and Inorganic Compounds** Many of the compounds found in living things contain the element carbon. Most compounds that contain carbon are called organic compounds. **Some important groups of organic compounds found in living things are carbohydrates, lipids, proteins, and nucleic acids.** As you may know, many of these compounds are found in the foods you eat. This is not surprising, since the foods you eat come from living things.

Compounds that don't contain the element carbon are called inorganic compounds. Water and sodium chloride, or table salt, are familiar examples of inorganic compounds. Organisms contain many inorganic compounds as well as organic compounds.



**Reading  
Checkpoint**

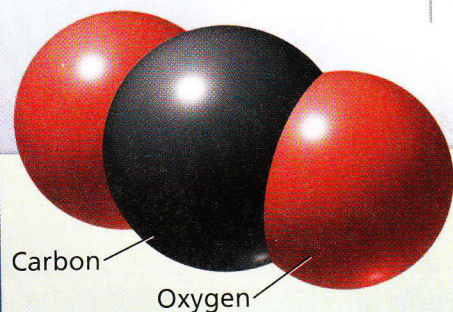
How are inorganic compounds different from organic compounds?

FIGURE 17

**Molecules and Compounds**

Carbon dioxide, which is found in the gas bubbles, is a chemical compound. So is water.

**Applying Concepts** What is a compound?

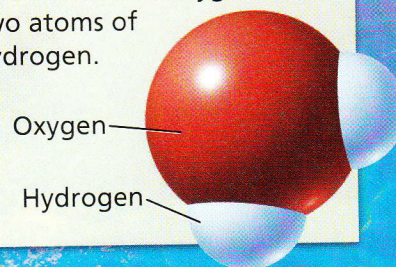


**Carbon Dioxide Molecule**

The air bubbles contain carbon dioxide. A carbon dioxide molecule has one atom of carbon and two atoms of oxygen.

**Water Molecule**

A water molecule is made up of one atom of oxygen and two atoms of hydrogen.





## Carbohydrates

A **carbohydrate** is an energy-rich organic compound made of the elements carbon, hydrogen, and oxygen. Sugars and starches are examples of carbohydrates.

Sugars are produced during the food-making process that takes place in plants. Foods such as fruits and some vegetables have a high sugar content. Sugar molecules can combine, forming large molecules called starches, or complex carbohydrates. Plant cells store excess energy in molecules of starch. Many foods that come from plants contain starch. These foods include potatoes, pasta, rice, and bread. When you eat these foods, your body breaks down the starch into glucose, a sugar that your cells can use to produce energy.

Carbohydrates are important components of some cell parts. For example, the cellulose found in the cell walls of plants is a type of carbohydrate. Carbohydrates are also found in cell membranes.



**Reading  
Checkpoint**

What is the difference between sugar and starch?

## Lipids

Have you ever seen a cook trim the fat from a piece of meat before cooking it? The cook is trimming away a lipid. Fats, oils, and waxes are all lipids. Like carbohydrates, **lipids** are energy-rich organic compounds made of carbon, hydrogen, and oxygen. Lipids contain even more energy than carbohydrates. Cells store energy in lipids for later use. For example, during winter, a dormant bear lives on the energy stored in fat within its cells. In addition, cell membranes are made mainly of lipids.



**FIGURE 18**

### Starch

These potatoes contain a large amount of starch. Starch is a carbohydrate. The blue grains in the close-up are starch granules in a potato. The grains have been colored blue to make them easier to see.

**FIGURE 19**

### Lipids

Olive oil, which comes from olives such as those shown here, is made mostly of lipids.

#### **Making Generalizations**

What elements are lipids composed of?





### What's That Taste?

Use this activity to discover one role that enzymes play in your body.

1. Put an unsalted soda cracker in your mouth. Chew it, but do not swallow. Note what the cracker tastes like.
2. Continue to chew the cracker for a few minutes, mixing it well with your saliva. Note how the taste of the cracker changes.

**Inferring** Soda crackers are made up mainly of starch, with little sugar. How can you account for the change in taste after you chewed the cracker for a few minutes?

FIGURE 20

#### Feathers Made of Protein

The feathers of this peacock are made mainly of protein.

**Applying Concepts** What smaller molecules make up protein molecules?

## Proteins

What do a bird's feathers, a spider's web, and your fingernails have in common? All of these substances are made mainly of proteins. **Proteins** are large organic molecules made of carbon, hydrogen, oxygen, nitrogen, and, in some cases, sulfur. Foods that are high in protein include meat, eggs, fish, nuts, and beans.

**Structure of Proteins** Protein molecules are made up of smaller molecules called **amino acids**. Although there are only 20 common amino acids, cells can combine them in different ways to form thousands of different proteins. The kinds of amino acids and the order in which they link together determine the type of protein that forms. You can think of the 20 amino acids as being like the 26 letters of the alphabet. Those 26 letters can form thousands of words. The letters you use and their order determine the words you form. Even a change in one letter, for example, from *rice* to *mice*, creates a new word. Similarly, a change in the type or order of amino acids can result in a different protein.

**Functions of Proteins** Much of the structure of cells is made up of proteins. Proteins form parts of cell membranes. Proteins also make up many of the organelles within the cell.

The proteins known as enzymes perform important functions in the chemical reactions that take place in cells. An **enzyme** is a type of protein that speeds up a chemical reaction in a living thing. Without enzymes, many chemical reactions that are necessary for life would either take too long or not occur at all. For example, enzymes in your saliva speed up the digestion of food by breaking down starches into sugars in your mouth.



Reading  
Checkpoint

What is the role of enzymes in cells?





## Nucleic Acids

**Nucleic acids** are very long organic molecules made of carbon, oxygen, hydrogen, nitrogen, and phosphorus. Nucleic acids contain the instructions that cells need to carry out all the functions of life.

There are two kinds of nucleic acids. Deoxyribonucleic acid (dee ahk see ry boh noo KLEE ik), or **DNA**, is the genetic material that carries information about an organism and is passed from parent to offspring. The information in DNA also directs all of the cell's functions. Most of the DNA in a cell is found in the chromatin in the nucleus. Ribonucleic acid (ry boh noo KLEE ik), or **RNA**, plays an important role in the production of proteins. RNA is found in the cytoplasm as well as in the nucleus.



**Reading  
Checkpoint**

What are the two kinds of nucleic acids? What are their functions?

## Math

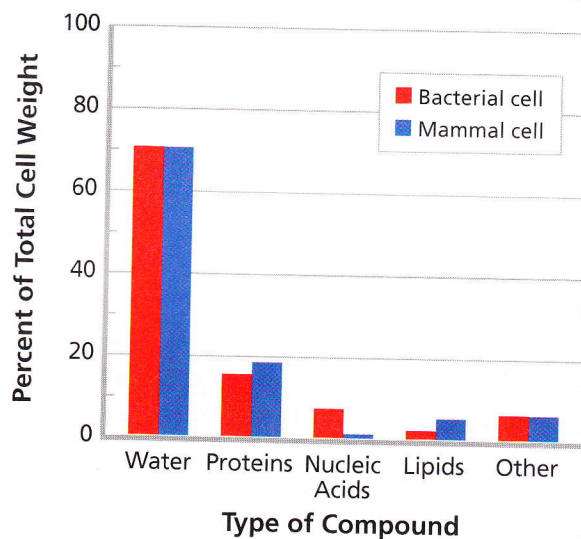
### Analyzing Data

#### Compounds in Bacteria and Mammals

All cells contain carbohydrates, lipids, proteins, and nucleic acids, as well as water and other inorganic compounds. But do all cells contain the same percentages of these compounds? The graph compares the percentages of some kinds of compounds found in a bacterial cell and a cell from a mammal.

- 1. Reading Graphs** What do the red bars represent? What do the blue bars represent?
- 2. Interpreting Data** What percentage of a mammalian cell is made up of water? How does this compare to the percentage of water in a bacterial cell?
- 3. Interpreting Data** Which kind of compound—proteins or nucleic acids—makes up the larger percentage of a mammalian cell?

#### Comparing Compounds in Cells



- 4. Drawing Conclusions** In general, how do a bacterial cell and a mammalian cell compare in their chemical composition?





## Water and Living Things

Did you know that water makes up about two thirds of your body? Water plays many important roles in cells. For example, most chemical reactions in cells involve substances that are dissolved in water. Also, water molecules themselves take part in many chemical reactions in cells. **Most chemical reactions within cells could not take place without water.**

Water also helps cells keep their size and shape. In fact, a cell without water would be like a balloon without air. In addition, because water changes temperature slowly, it helps keep the temperature of cells from changing rapidly. In the next section, you'll learn about the role that water plays in carrying substances into and out of cells.



**Reading  
Checkpoint**

What compound is needed for most chemical reactions to take place in cells?

FIGURE 21

### Mostly Water

About two-thirds of the human body is water.

**Relating Cause and Effect** How does water help regulate body temperature?

## Section 3 Assessment



### Target Reading Skill

**Comparing and Contrasting** Use the information in your table to help you answer the questions below.

### Reviewing Key Concepts

1. a. **Defining** What is an element?  
b. **Comparing and Contrasting** How is a compound different from an element?  
c. **Classifying** A molecule of ammonia consists of one atom of nitrogen and three atoms of hydrogen. Is ammonia an element or a compound? Explain.
2. a. **Reviewing** What are four types of organic molecules found in living things?  
b. **Classifying** Which of the four types of organic molecules contain the element nitrogen?  
c. **Inferring** An organic compound contains only the elements carbon, hydrogen, and oxygen. Could this compound be a carbohydrate? Could it be a protein? Explain.

3. a. **Reviewing** What three important functions does water perform in cells?  
b. **Relating Cause and Effect** Suppose a cell is seriously deprived of water. How might this lack of water affect the cell's enzymes? Explain.

**Lab  
zone**

### At-Home Activity

**Compounds in Food** With family members, look at the "Nutrition Facts" labels on a variety of food products. Identify foods that contain large amounts of the following organic compounds: carbohydrates, proteins, and fats. Discuss with your family what elements make up each of these compounds and what roles they play in cells and in your body.